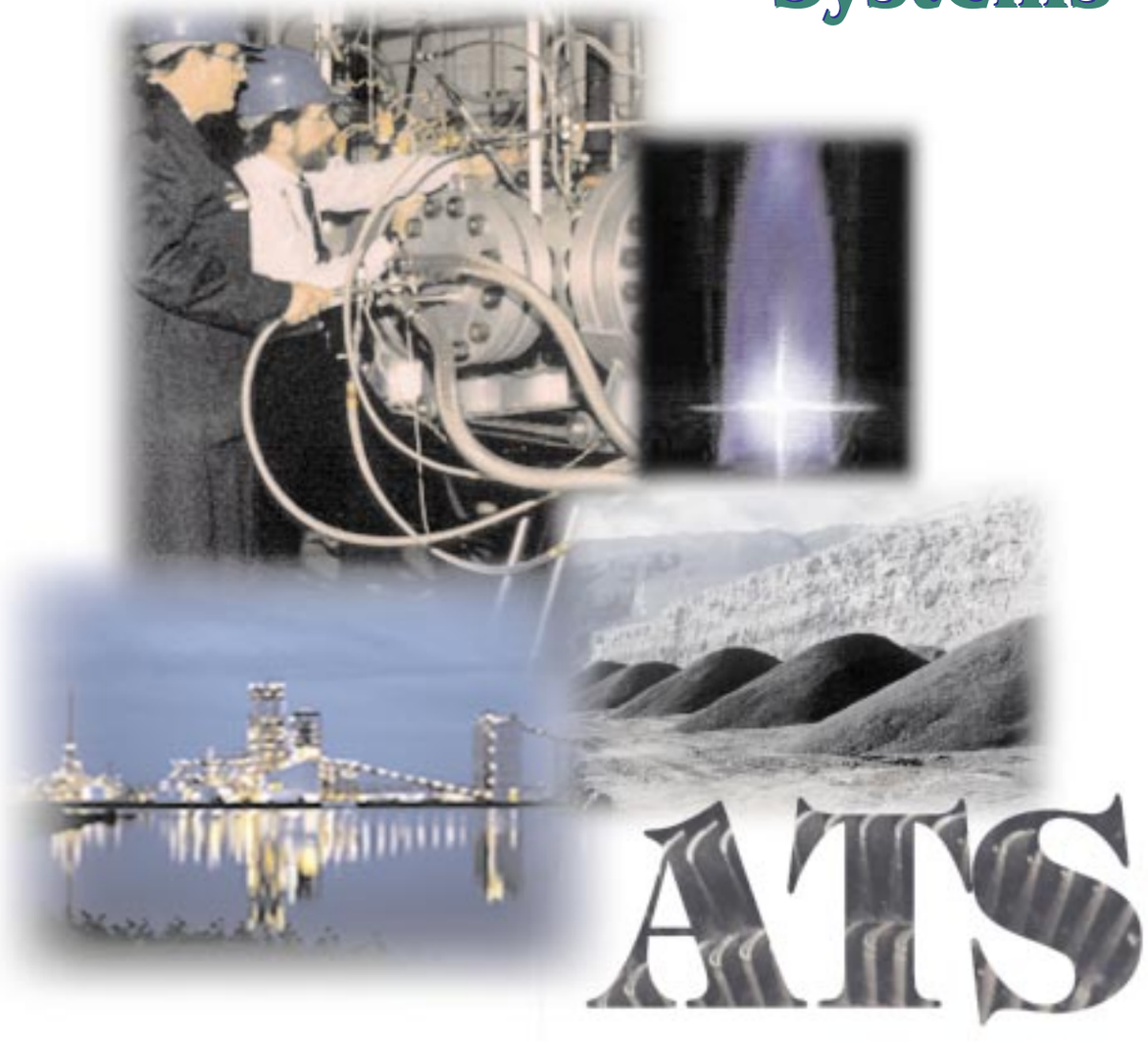
U.S. Department of Energy

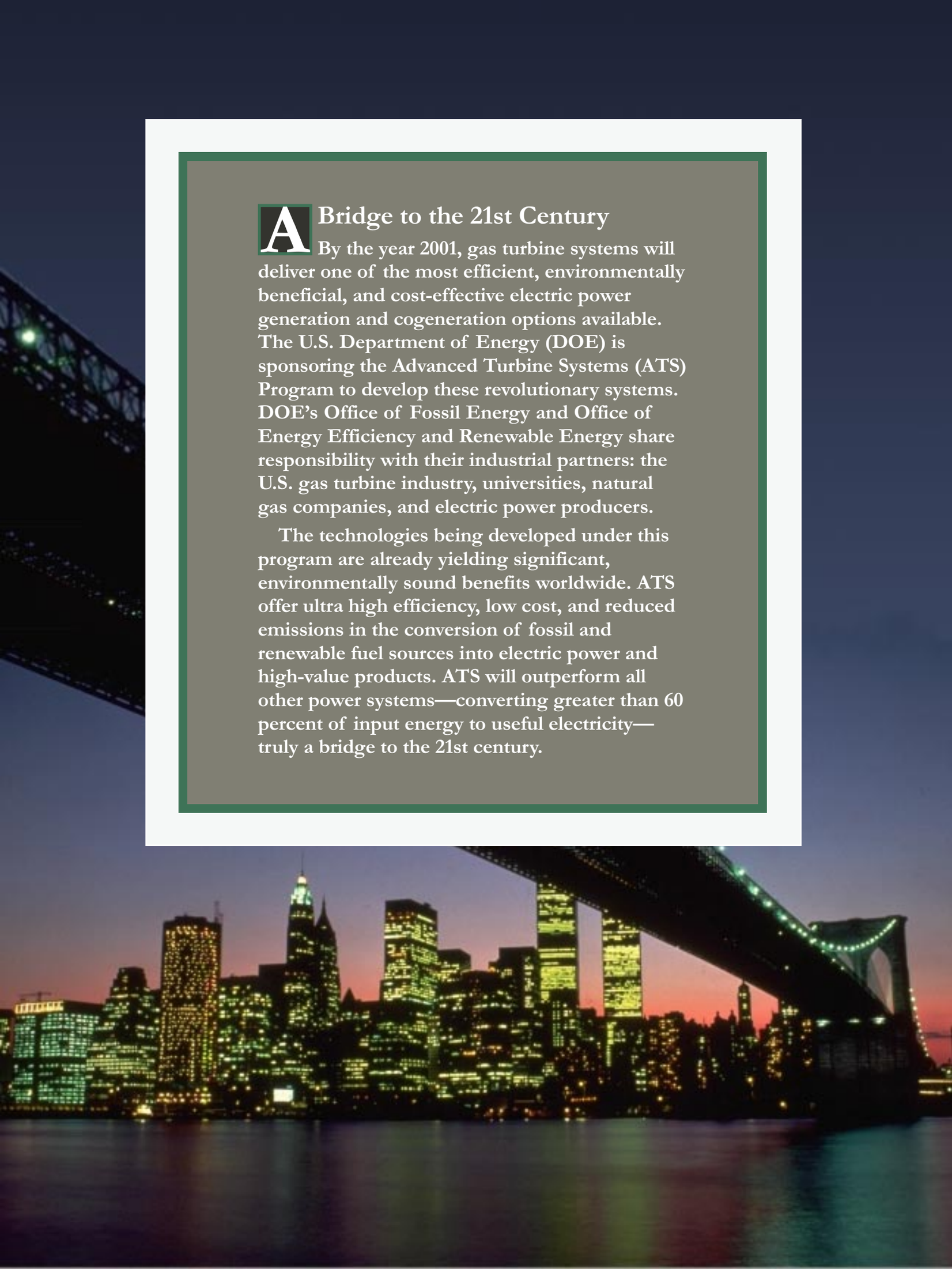
Office of Industrial Technologies & Federal Energy Technology Center

Advanced Turbine Systems



Providing Clean, Affordable Energy

- *Office of Energy Efficiency and Renewable Energy*
- *Office of Fossil Energy*



A Bridge to the 21st Century

By the year 2001, gas turbine systems will deliver one of the most efficient, environmentally beneficial, and cost-effective electric power generation and cogeneration options available. The U.S. Department of Energy (DOE) is sponsoring the Advanced Turbine Systems (ATS) Program to develop these revolutionary systems. DOE's Office of Fossil Energy and Office of Energy Efficiency and Renewable Energy share responsibility with their industrial partners: the U.S. gas turbine industry, universities, natural gas companies, and electric power producers.

The technologies being developed under this program are already yielding significant, environmentally sound benefits worldwide. ATS offer ultra high efficiency, low cost, and reduced emissions in the conversion of fossil and renewable fuel sources into electric power and high-value products. ATS will outperform all other power systems—converting greater than 60 percent of input energy to useful electricity—truly a bridge to the 21st century.

ATS

A Revolutionary System

The United States needs increased electric generating capacity and, at the same time, reduced emissions from electric power generating plants. The U.S. Department of Energy (DOE) is working to ensure clean, affordable energy for our nation now and in the future.

DOE initiated the Advanced Turbine Systems (ATS) Program in 1992 to produce 21st century gas turbines—systems that are more efficient, cleaner, and less expensive to operate than today's turbines. DOE's Office of Fossil Energy's Federal Energy Technology Center and Office of Energy Efficiency and Renewable Energy's Office of Industrial Technologies share responsibility with industrial partners for developing these revolutionary systems. The program combines the resources of the government, major turbine manufacturers, suppliers, and universities. DOE and individual participants fund ATS projects in such a way that the level of cost-sharing from the participants increases as the technology risks decrease.

DOE is developing a high-efficiency, ultra-clean gas turbine that will break through the operating temperature limits of today's technology. The utility-scale ATS power plants are advanced combined cycles that will be developed to generate power with a lower cost of electricity through high efficiency and low NO_x emissions. Current commercially available, combined-cycle power plants have an average net electrical efficiency of 55 percent. The ATS will be demonstrated at a 60-percent efficiency by the year 2001.

What is a Gas Turbine?

A gas turbine is a heat engine that uses a high-temperature, high-pressure gas as the working fluid. Part of the heat supplied by the gas is converted directly into the mechanical work of rotation. In most cases, the hot gases for operating a gas turbine are obtained by burning a fuel in air, which is why gas turbines are often referred to as "combustion" turbines. Because they are compact, lightweight, and simple to operate, gas turbines have been widely used, notably in jet aircraft and in electricity generation. Gas turbines are used in industrial and utility settings to produce electricity and steam. (Many industrial processes require steam in addition to electricity.) In such cases, "simple cycle" gas turbines convert a portion of input energy to electricity and use the remaining energy to produce steam in a steam generator. For utility applications, which require maximum electric power, a "combined cycle" steam turbine is added to convert steam to electricity.

GOAL
Program Goal

The ATS Program emphasis is to reduce the cost of generating electricity with gas turbines while increasing their efficiency and lowering emissions. ATS turbines are projected to enter the pre-commercial demonstration stage by the year 2000; commercialization of ATS is expected by 2002.

PROGRAM
ATS Program

Gas turbines being developed under the ATS Program are:

(1) simple-cycle industrial gas turbines, for distributed generation, industrial, and cogeneration markets; and
(2) gas turbine, combined-cycle systems, for large, baseload, central-station electric-power generation markets.

Expectations are to meet or exceed 60-percent system efficiencies in the utility market, and to increase efficiencies of industrial turbines by 15 percent. The new turbines emit far less nitrogen oxides, carbon dioxide, and unburned hydrocarbon emissions than current gas turbine systems.

Projects in the ATS Program are organized under two major activities: (1) major systems development, and (2) technology base development. Participants in major systems development are turbine manufacturers actively engaged in developing an ATS. Technology base development consists of projects that support major systems development and evaluate future advancements for gas turbine systems. Supporting technologies at suppliers and National Labs and academic research are also sustained under this activity.

Fuel Flexibility

The technology is designed to be fuel-flexible, allowing a coal-derived gas or renewable biomass-based gas to be used as well as natural gas. This makes ATS available to a wider market and minimizes the economic impact to the U.S. if gas prices increase.

Advanced Turbine Systems Developed to Satisfy the World's Future Power Needs

Advanced turbine systems are poised to raise the overall efficiency of the world's power generation capacity and lower the overall global emissions. In partnership with DOE, industry, universities, and federal agencies are making the ATS Program a success to ensure clean, affordable energy for our nation.

A cooperative effort including DOE, industry, universities, and federal agencies will deliver efficient, clean, cost-effective electric power generation and cogeneration options.

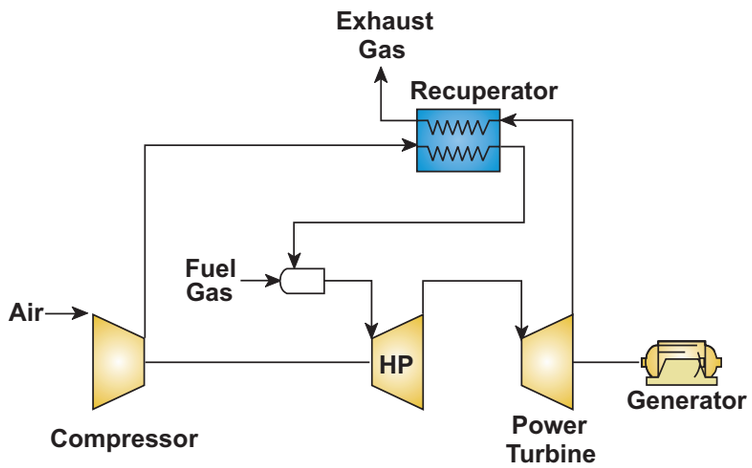
OBJECTIVE

Program Objective

By 2000, develop ATS for utility and industrial applications that are . . .

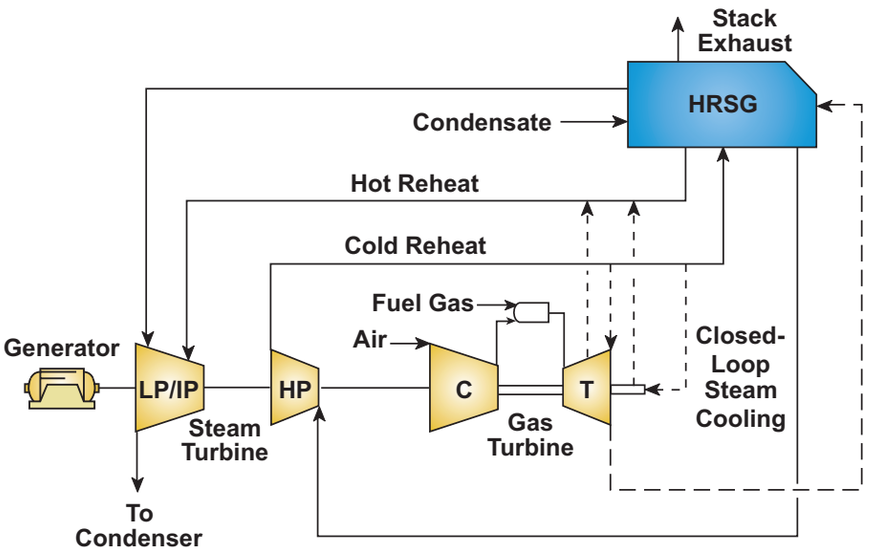
- Ultra efficient: greater than 60-percent efficiency for utility scale systems, and 15 percent improvement in efficiency for industrial systems
- Super clean: nitrogen oxides emissions at less than 9 ppm
- Economical: 10 percent lower than the current cost of electricity
- Fuel flexible: primary focus on natural gas

Industrial Advanced Gas Turbine Systems



Recuperated Gas Turbine

Utility Advanced Gas Turbine System

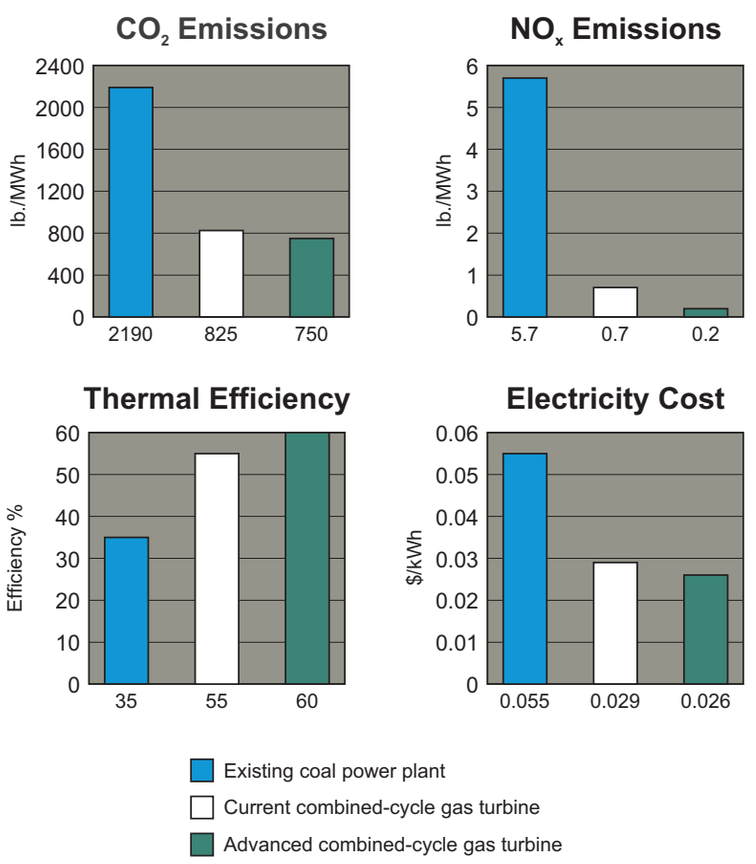


Combined Cycle With Closed-Loop Steam Cooling

Benefits

Program Benefits

- Cleaner environment
- Lower cost of electricity
- Secure, reliable electric power supply
- Continued use of coal and natural gas, our most plentiful fossil fuels
- Reduced carbon dioxide and nitrogen oxides emissions
- Stronger power industry, stronger economy, and more jobs



Between 1995 and 2020, the world's annual consumption of electricity is projected to rise from 12 trillion kilowatt-hours (kWh) to 23 trillion kWh.

International Energy Outlook 1998, April 1998—Energy Information Administration, Office of Integrated Analysis and Forecasting, U.S. Department of Energy

FETC is a field office of DOE's Office of Fossil Energy

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